Jet Propulsion Laboratory
California Institute of Technology

A Business Opportunity for Sharing Golden Part Information

Jerry Martinez, Part Specialist
Component Engineering & Assurance Office
Office of Safety and Mission Success
gerald.m.martinez@jpl.nasa.gov

2018 SMTA/CALCE Symposium on Counterfeit Parts & Materials, June 26, 2018

Outline

- The problem – the need
- What's out there – the untapped resources
- What's possible – what these resources can provide
- What it'll take to get it done – a few options

The Problem

- Every month, more electronic parts become obsolete; that is, unavailable from their manufacturers or authorized distributors
- Many of us don't know exactly what the genuine parts are supposed to look like: shape and texture, marking technology, marking font, manufacturer logo size and placement, material formulations, etc.
- Most of the labs offering authentication services also don't know what these parts are supposed to look like
- Authentication analyses contain uncertainty

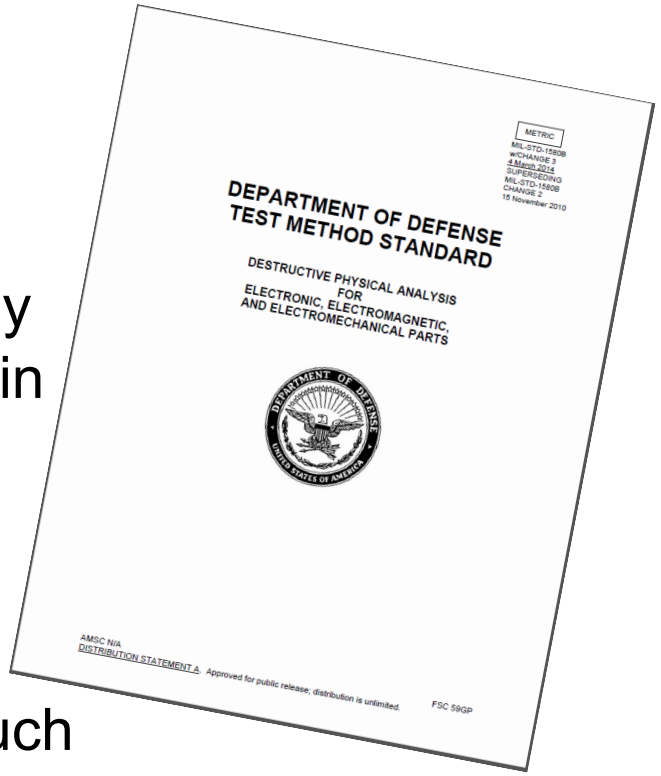
What's Out There

- Original equipment manufacturers (OEMs) have destructive physical analysis (DPA) reports of parts they've used, and often virgin parts
- Original component manufacturers (OCMs) have design information for parts they've made, and for manufacturers they've acquired or merged with
- OCMs have DPA reports of parts they've made when customers have ordered these reports
- DPA labs have copies of reports they've done, for multiple customers
- Electrical test labs have golden parts for reference (just 1 or 2)
- Some of these entities may also have constructional analysis (CA) reports of some parts, as requested

What's Out There: The DPA Reports

What is a DPA?

A destructive physical analysis (DPA) is an "assessment of part lot quality based on the destructive examination of samples randomly selected from each production lot," typically in accordance with MIL-STD-1580 or some tailored variation of it. A DPA is a series of specific nondestructive and increasingly destructive analytical steps defined by part type and construction that will provide as much information as possible about a lot's quality.


METRIC
MIL-STD-1580B
w/CHANGE 3
4 March 2014
SUPERSEDING
MIL-STD-1580B
CHANGE 2
15 November 2010

DEPARTMENT OF DEFENSE
TEST METHOD STANDARD

DESTRUCTIVE PHYSICAL ANALYSIS
FOR
ELECTRONIC, ELECTROMAGNETIC,
AND ELECTROMECHANICAL PARTS

AMSC N/A
DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.
FSC 59GP

A failure analysis is not a DPA, though it will often contain some of the same information

What's Out There: The DPA Reports

What does a DPA include?

Depends on the part type:

- Overall photo, including markings
- X-rays—typically three 90° views
- Internal photos, including overall die photos
- Cross sections
- For diodes—basic electrical parameters
- Residual gas analysis (RGA or IGA)
- Particle impact noise detection (PIND), hermeticity, bond pull, die shear, solderability, scanning electron microscope (SEM) metallization examination

Ideally, you want golden part info on the same part family, from nearly the same date code, or date codes bracketing your samples

What's Out There: Golden Parts

Also known as known good, known authentic, exemplar

Exemplar: "A functioning part having a known, unbroken chain of custody to the OCM/OEM or authorized manufacturer with specified characteristics or requirements" (SAE AS6171)

Known authentic: "A part which has either been purchased directly from the manufacturer, their authorized distributors, or authenticated by the manufacturer with supporting documentation" (SAE AS6081)

- Intact parts retained from DPAs as "failure analysis samples"
- Intact parts kept for reference by test labs (primarily ICs)
- Excess inventory procured "back in the day" by OEMs and still stored by them
- Traceable excess inventory procured from OCMs and OEMs

What's Out There: Use of Golden Parts

SAE AS6081, paragraph 4.2.6.4.3.C (for example):

Scanning Electron Microscope (SEM) for Microblast Resurfacing (Additional Test as agreed between Customer and Organization):

A SEM can produce very high-resolution images of a sample surface, revealing details less than 1 nm in size or about 250 times the magnification limit of the best optical microscopes. The test that shall be performed here is a form of visual test that *compares the surfaces of a part* within the lot being inspected and from the test lot against the virgin surface of *a known authentic part of the same or proximate date and lot code, as available*…." [emphasis added]

What's Out There: Use of Golden Parts

SAE AS6081, paragraph 4.2.6.4.4 (for example):

Radiological (X-ray) Inspection:

…Radiographic analysis by use of X-rays shall be performed to verify that the internal package or die construction is consistent within the lot being inspected and versus OCM-supplied data and/or with a known authentic part of the same or proximate date and lot code, *as available*…..” [emphasis added]

That's the hard part: “*as available*”

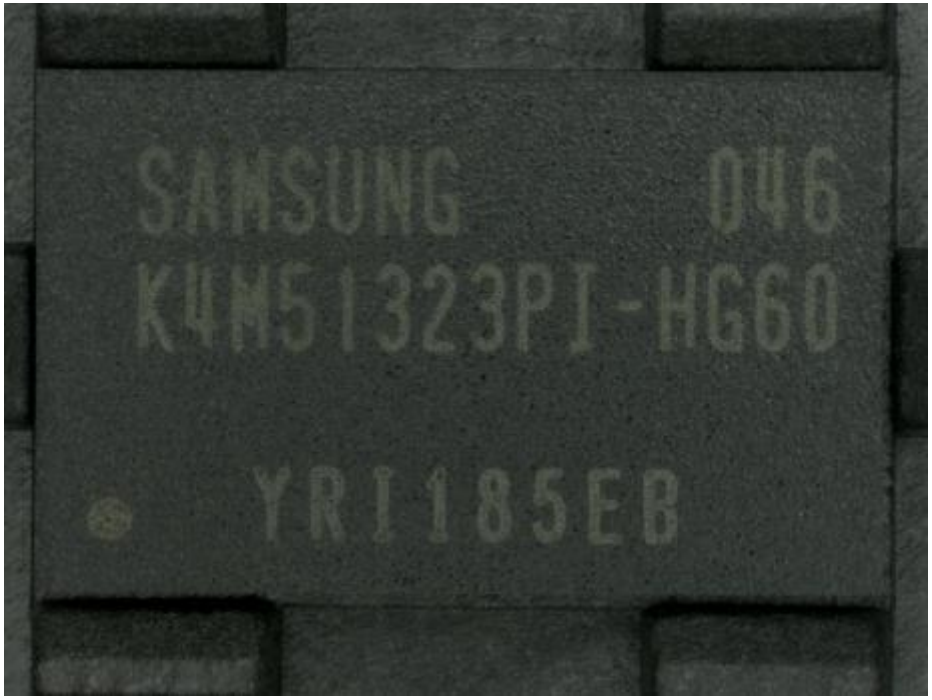
Who's Out There: Sources and Customers

Some companies could be sources of DPA reports, sources of golden parts, and/or providers of counterfeit detection services

- Company 1: Established military OEM, with decades of DPA reports but no golden parts, offers counterfeit detection services
- Company 2: Space OEM who had decades of DPA reports, but threw away all the old ones (>5 years old); offers outside counterfeit detection services
- Company 3: Established space OEM with old DPAs and golden parts ("FA samples"), no outside counterfeit detection services
- Company 4: Offers detection services, but has no DPA reports or golden parts
- Company 5: Unauthorized independent distributor with OCM documentation of known-good parts—stocking or outside inventory
- Company 6: Established OEM with excess inventory of known-good parts

What's Possible: External View Example

Obsolete Samsung integrated circuit, K4M51323PI-HG60:

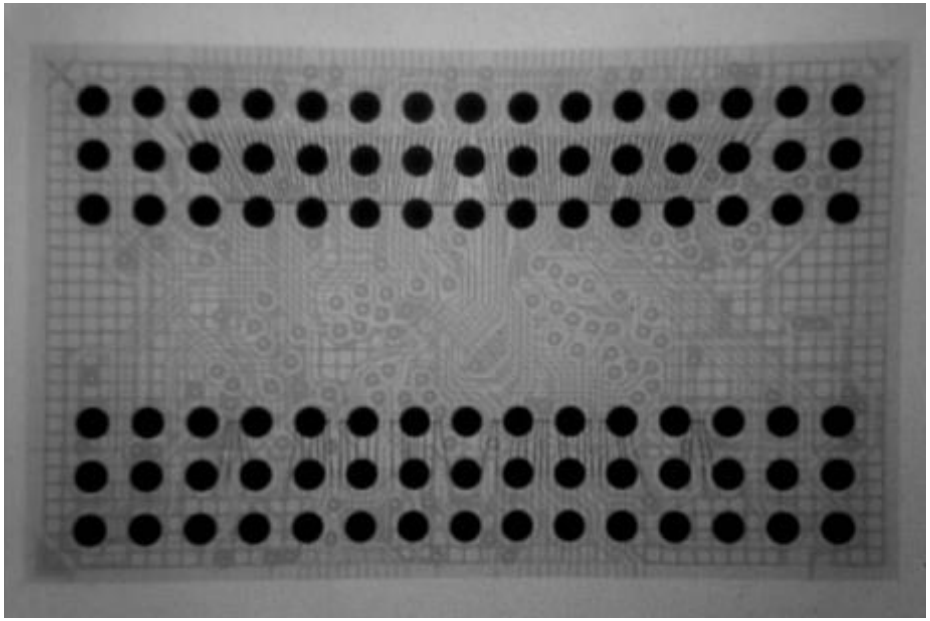


Unknown provenance, D/C 1046

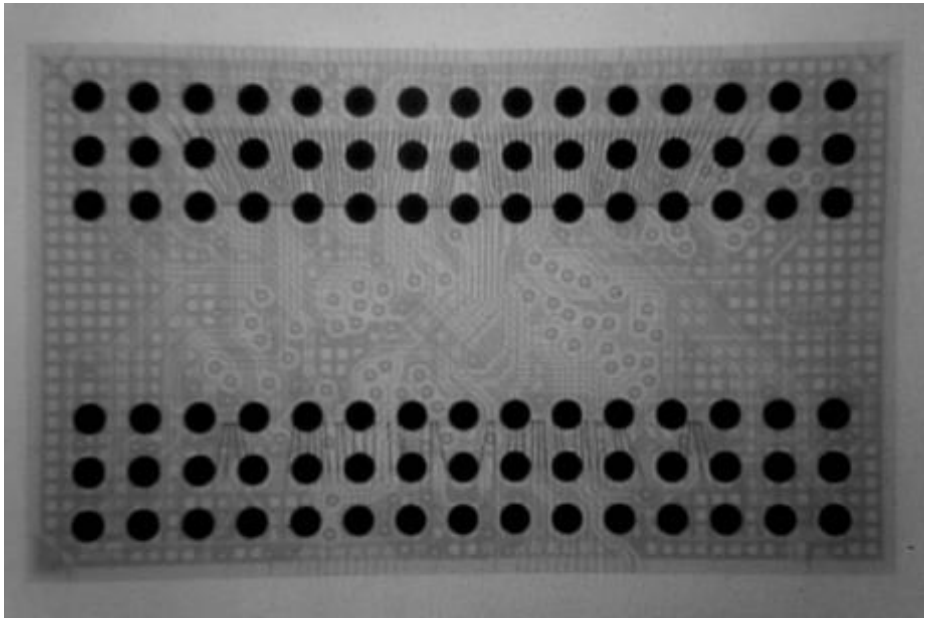
Known good, date code 1037

What's Possible: X-ray Example

Obsolete Samsung integrated circuit, K4M51323PI-HG60:



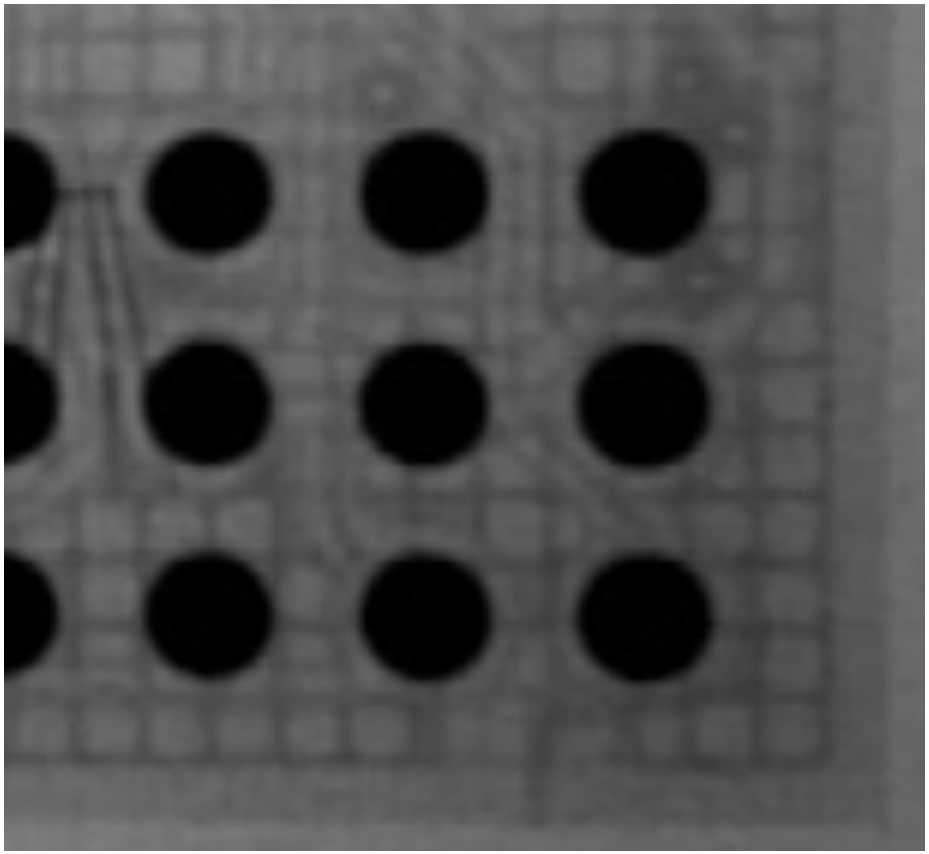
Unknown provenance, D/C 1046



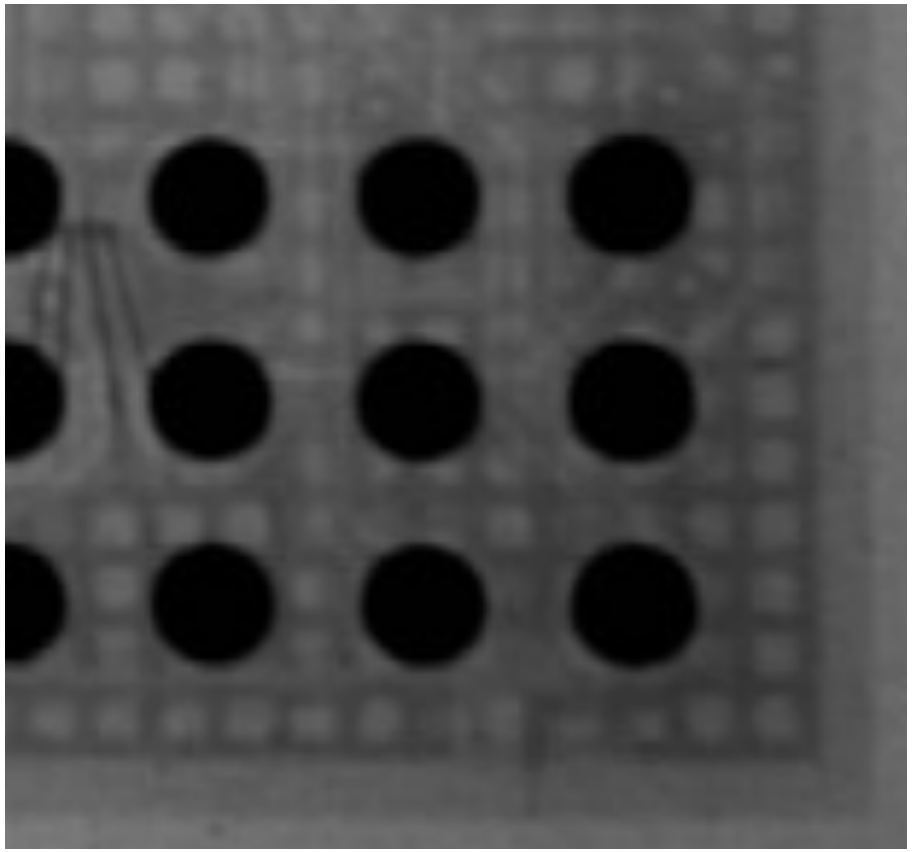
Known good, D/C 1037

What's Possible: X-ray Example

Obsolete Samsung integrated circuit, K4M51323PI-HG60, detail:



Unknown provenance, D/C 1046



Known good, D/C 1037

What's Possible: Markings Example 1

Obsolete Harris integrated circuit, 5962R9570801QJC:

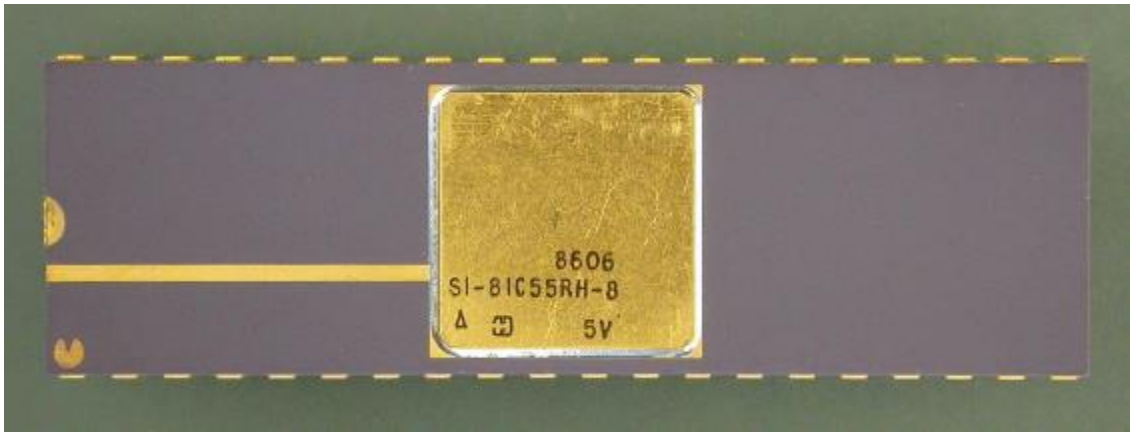
Unknown origin, D/C 9501A

Unknown origin, D/C 9844

What's Possible: Markings Example 2

Obsolete Harris integrated circuit, HS1-81C55RH-8:

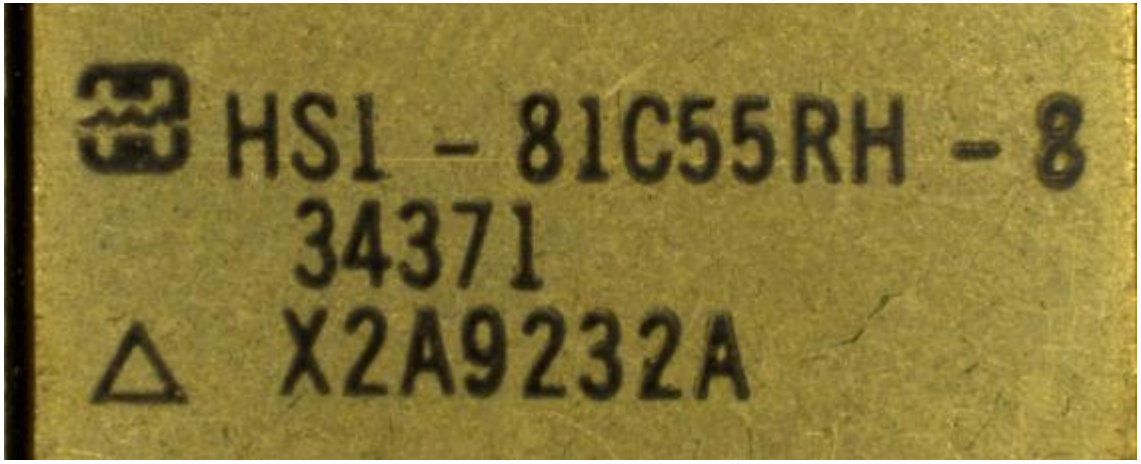
Unknown origin, D/C 9232A



Known good, D/C 8606

What's Possible: Markings Example 2

Obsolete Harris integrated circuit, HS1-81C55RH-8:

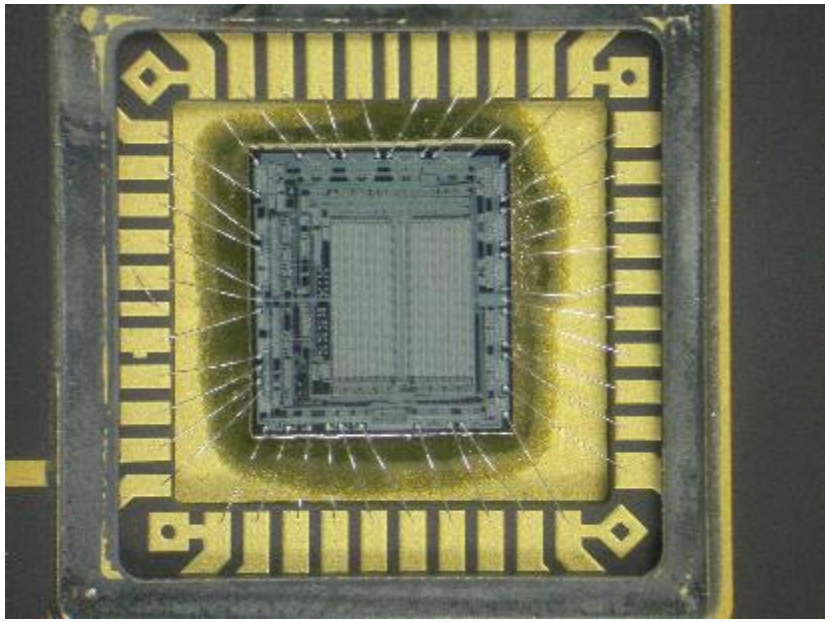


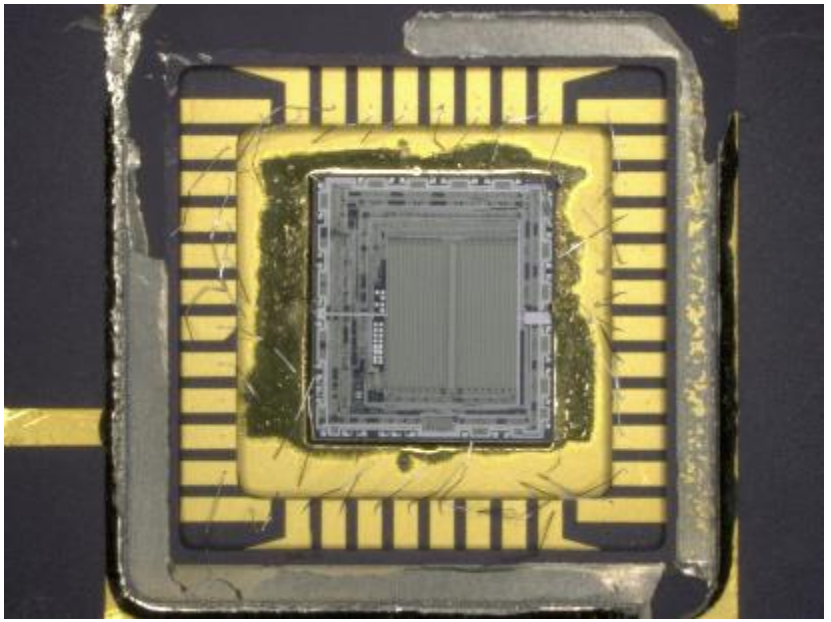
Unknown origin, D/C 9232A

Known good, D/C 8606

What's Possible: Overall Internal Views

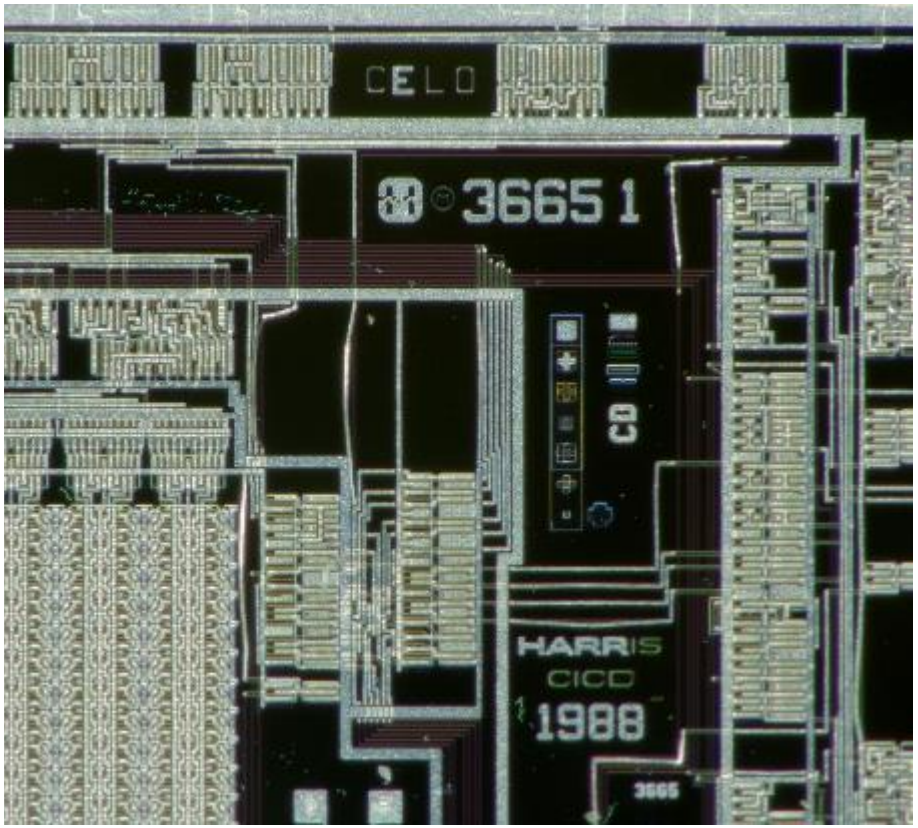
Comparing internal details: Harris HS1-81C55RH-8, D/C 9232 of questionable provenance versus a golden D/C 8606 part

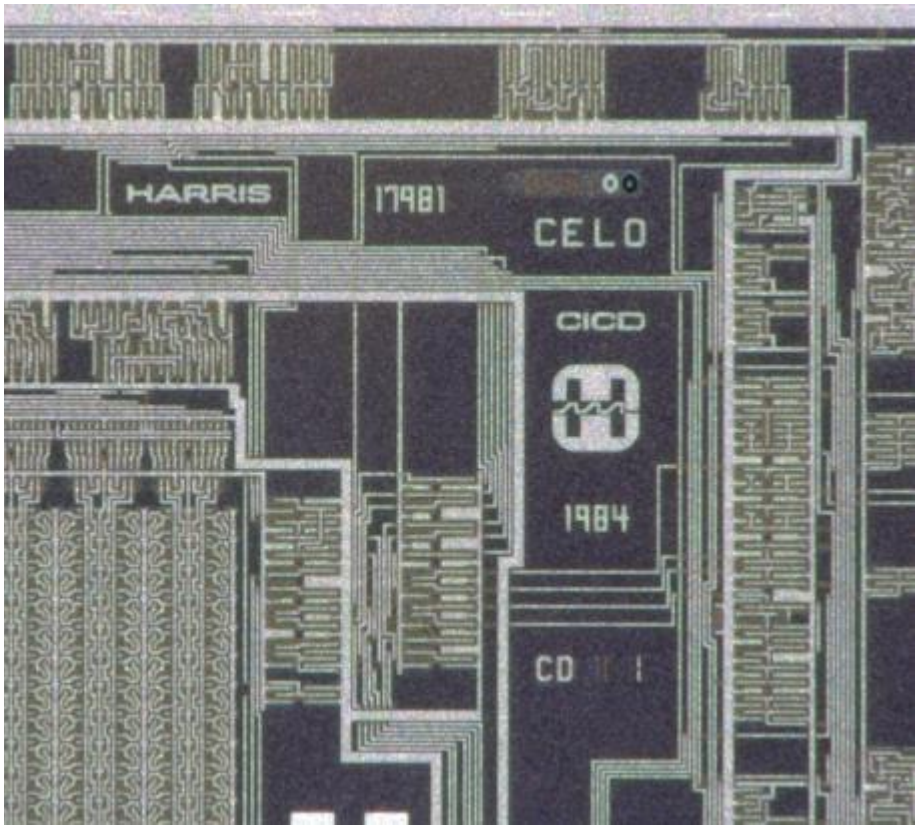




What's Possible: Die Markings

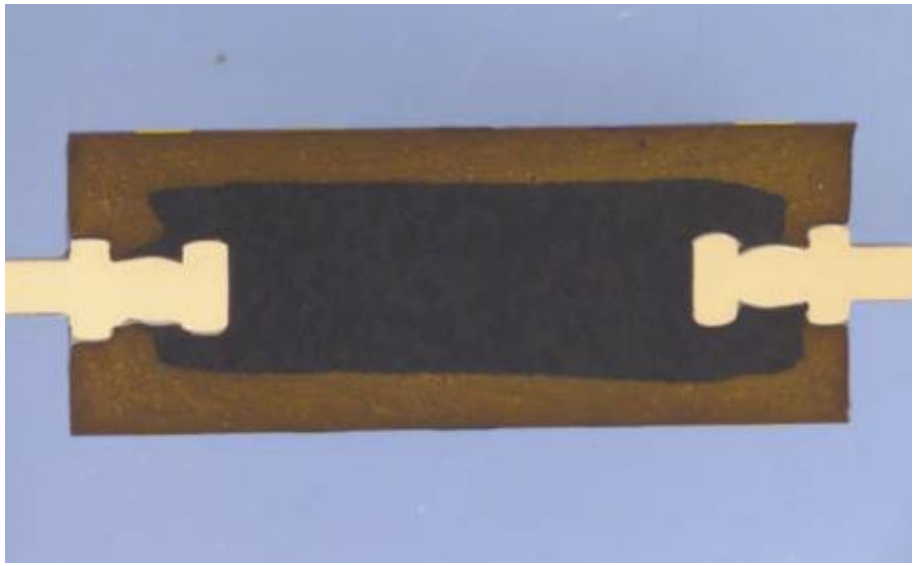
Comparing internal details: Harris HS1-81C55RH-8, D/C 9232 of questionable provenance versus a golden D/C 8606 part

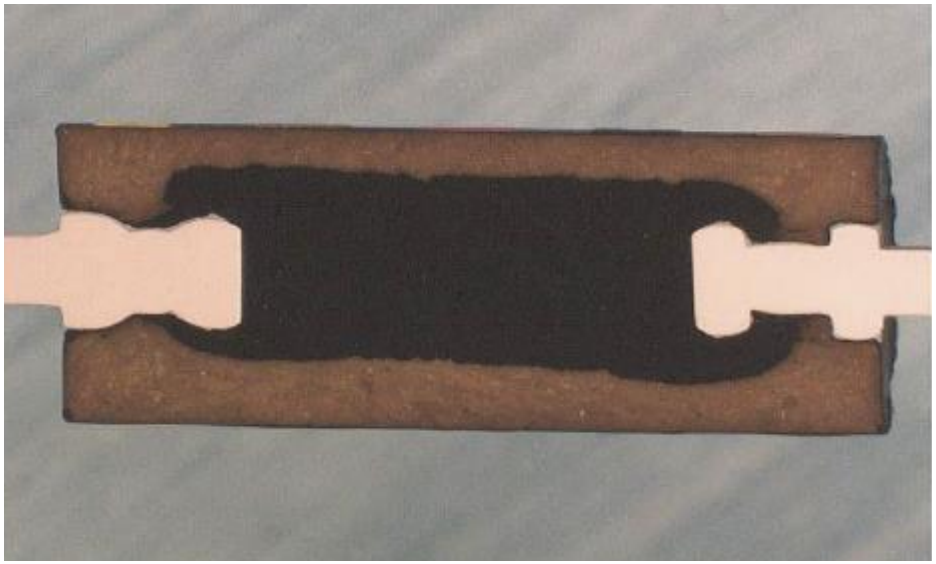




What's Possible: Cross Section Example

Comparing constructional details: Resistor of questionable provenance and DPA cross section of golden Allen-Bradley part:





What's Possible: Materials Comparisons

From the 2013 Counterfeit Electronic Parts and Electronic Supply Chain Symposium:

Material Based Authentication

Diganta Das, PhD and Bhanu Sood,
Center for Advanced Life Cycle Engineering (CALCE)

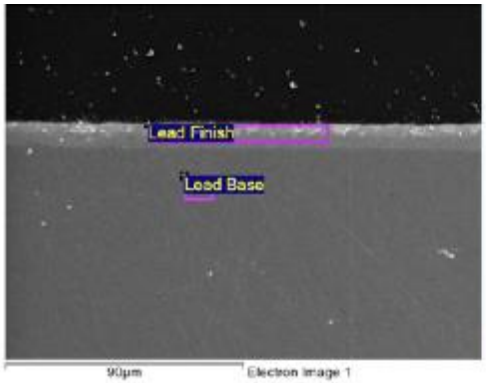
University of Maryland, College Park, MD, USA

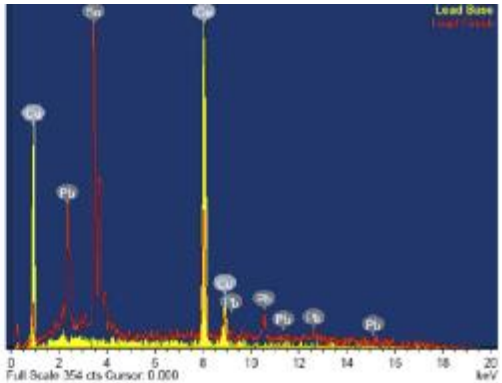
calce University of Maryland

"The goal of this work is to be able to decide if a part is a counterfeit or not, without needing a genuine part to compare a part against."

What's Possible: Material Comparisons

Elemental analysis of questionable vs. golden Allen-Bradley resistors' resistive material composition

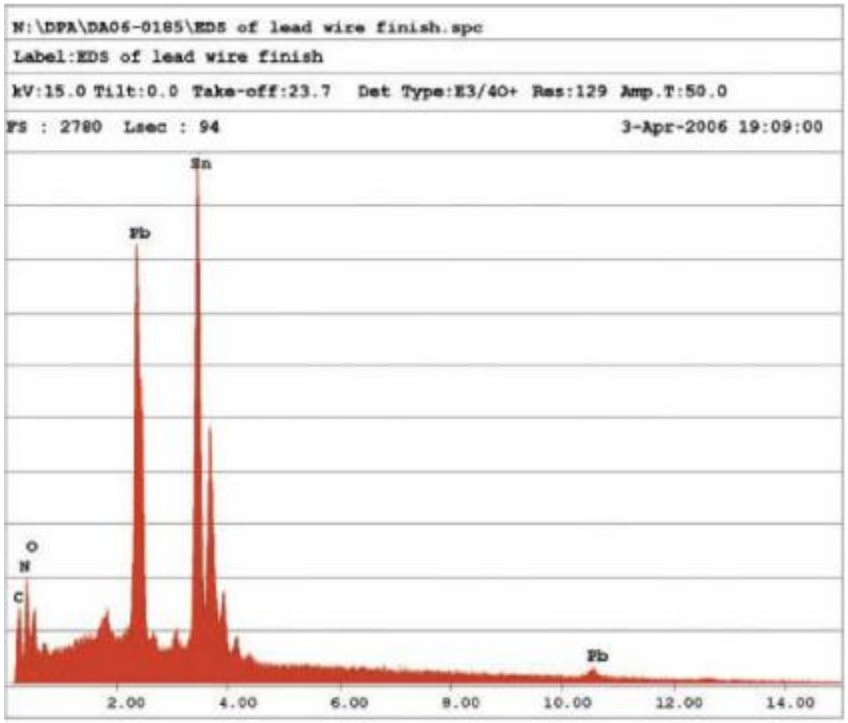




Processing option : All elements analysed (Normalised)

Spectrum	In stats.	Cu	Sn	Pb	Total
Lead Finish	Yes	31.95	51.52	16.53	100.00
Lead Base	Yes	100.00			100.00
Max.		100.00	51.52	16.53	
Min.		31.95	51.52	16.53	

All results in weight%



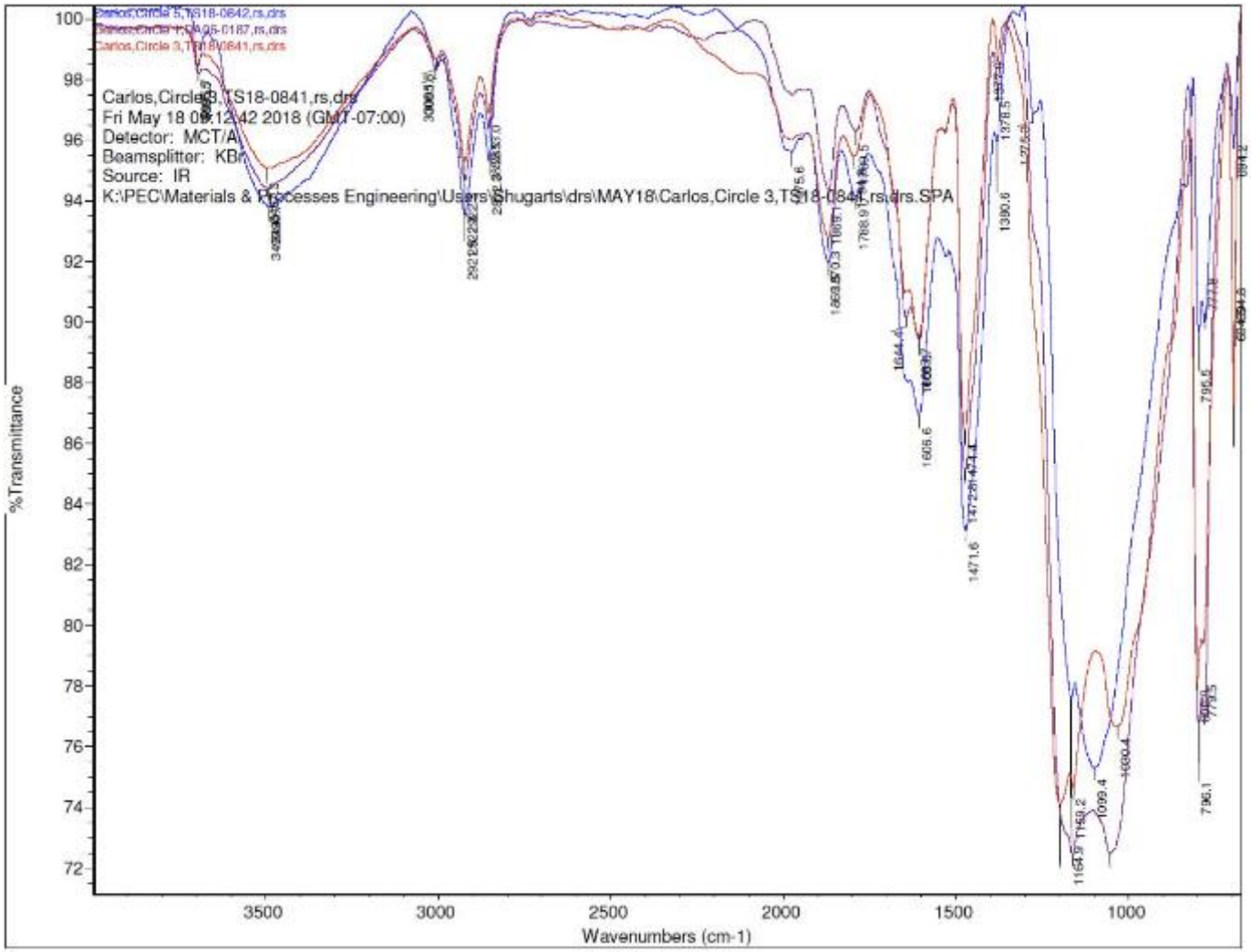
EDAX ZAF Quantification (Standardless)
Element Normalized
SEC Table : Default

Element	Wt %	At %	K-Ratio	Z	A	F
PbM	36.30	24.61	0.3324	0.9392	0.9747	1.0003
SnL	63.70	75.39	0.5495	1.0282	0.8390	1.0000
Total	100.00	100.00				

Element	Net Inte.	Bkgd Inte.	Inte. Error	P/B
PbM	174.71	18.19	0.86	9.60
SnL	242.41	15.90	0.70	15.24

What's Possible: Material Comparisons

Chemical (Fourier transform infrared) analysis of two questionable vs. one golden Allen-Bradley resistors' molded package composition



What It'll Take To Get It Done: Options

- Right now: You can go to a lab that has DPA reports and/or golden parts, and if you're very lucky, they'll have info on the parts you need—not very helpful most of the time

- Right now: As above, but if the lab doesn't have info on the parts you need, you can search for known good parts yourself or ask them to search—better chance of success, but still not high

- A better way: Labs would establish connections with sources of DPA reports or known good parts, and advertise such comparisons as part of their counterfeit detection services

What It'll Take To Get It Done: Options

<u>The best way</u>

One organization would establish relationships and agreements with all possible sources and customers:

- Independent distributors of stocked inventories with provenance
- Distributors of inventoried OEM excess part stock
- OEMs with uncatalogued excess stock—may be only one part
- OEMs with DPA reports
- OCMs to arrange last buys of obsolescent parts
- DPA labs with archived reports
- Electrical test labs with golden parts

Use of multiple parts and/or DPA reports from multiple sources could help to bracket an unknown lot

What It'll Take To Get It Done: Considerations

- Organization would need nondisclosure agreements/proprietary information agreements with all sources of parts and DPA reports
- Labs would have to be able to state supply chain information for golden parts and DPA reports
- Organization should have criteria to vet their customers—to ensure that golden parts and DPA reports aren't purchased by counterfeiters
- Organization should strive to match or bracket date codes of interest as well as possible, from same part number or similar part families
- *One known good part or DPA report* can be all we need to authenticate entire lots of parts of unknown provenance
- What would this information be worth to customer? Perhaps much
- Is someone willing to *be* this organization?

Jet Propulsion Laboratory
California Institute of Technology